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The Journal of the INSTITUTION OF PRODUCTION ENGINEERS

Vol. XXI No. 5

MAY, 1942

CONTENTS

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Price 5/-

'CUTANIT SERVICE'
THE HANDBOOK
MACHINISTS HAVE
BEEN WAITING FOR

Some of the contents :

- Production Efficiency
- Round Britain's Workshops
- Causes of failures in tools
- Useful Tables of interest to Cemented Carbide users
- Cutanit and how to apply it
- Brazing instructions
- Grinding instructions
- Cutanit Calculator

84 pages with many tables and figures

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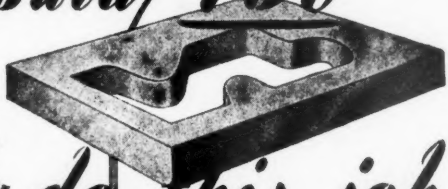
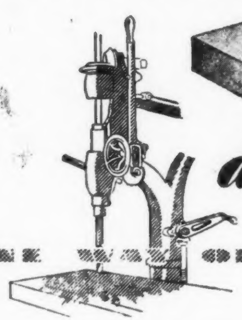
Brightside Works, Sheffield 1

or **J. J. SAVILLE & CO. LIMITED**
Triumph Steel Works, Sheffield 1

how would YOU do this job?



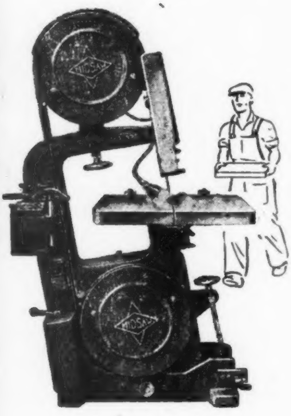


CUT AN IRREGULAR SHAPED HOLE IN A PIECE OF STEEL PLATE 2" THICK

ONE WAY OF DOING IT

Drill a series of holes at intervals round the marking line. Join them up with a cold chisel; finish with a hand file. This method is still used in hundreds of shops, taking up many hours of skilled labour.

OUR WAY OF DOING IT



Drill one hole. Put the job on a Midsaw Toolroom Bandsaw; thread the blade through the hole and join its ends by the special brazing attachment (2 minutes). Saw the shape slickly and accurately to the marking line. Change the sawing band for the filing band, which converts the Midsaw from a bandsaw into a bandfile. Finish as required.

●

In speed and accuracy there is no comparison between the two methods. The Midsaw wins hands down. And, what is equally important, it releases highly skilled labour, for Midsaw can be worked quite satisfactorily by an intelligent youth.

●

If you are still employing the old method—

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The MIDLAND SAW & TOOL CO. Ltd.

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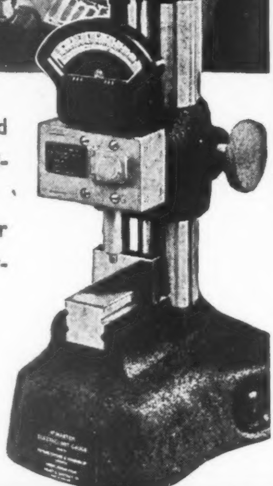
How *Inspection keeps pace with production by*

ELECTROLIMIT GAUGING



With these gauges small parts are checked and graded by tenths for selective assembly to similarly graded components.

In this way engines and machines go together with speed and precision giving maximum performance in operation.

Obtainable through—

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MANUFACTURED UNDER PRATT & WHITNEY LICENCE

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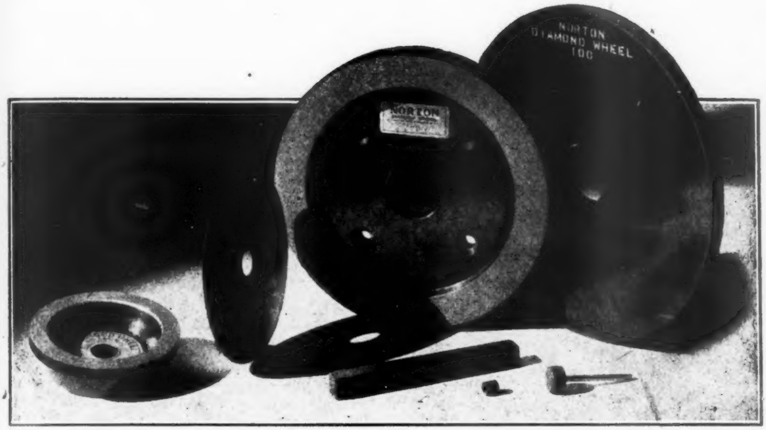
NORTON DIAMOND WHEELS



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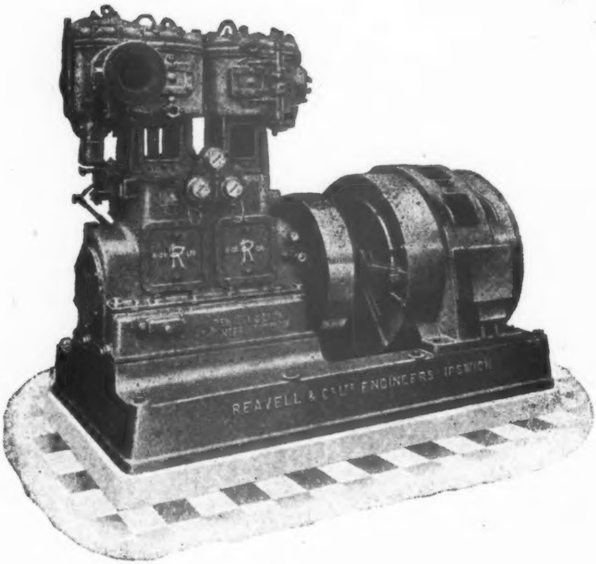

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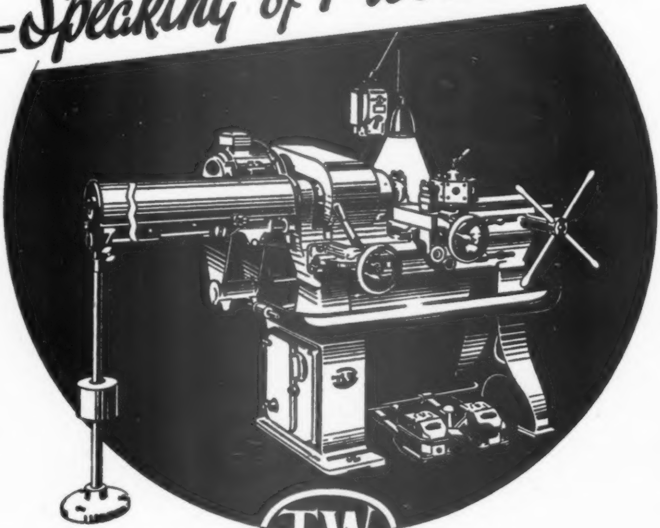

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CAPSTAN LATHES

set a standard of High-Speed Production of work to close limits that it is difficult to beat

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"The mortal crime would be a weakening in our purpose."
THE PRIME MINISTER

Leytonstone
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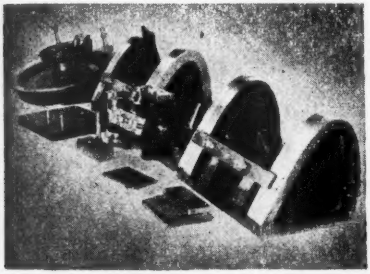
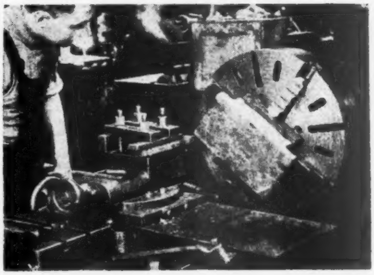

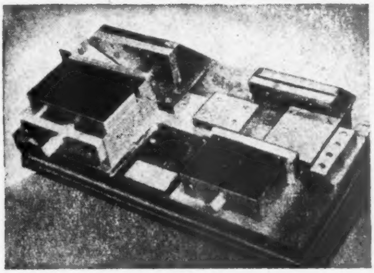

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one machine instead of three

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With this one machine a wide variety of standard sharpening operations can be performed. In addition, several specialized grinding operations can be handled with greater speed and economy than formerly, yet with no sacrifice of accuracy. Following of spiral leads, indexing, diameter size, blade profile, feed to wheel on tooth face grinding, diameter cutting clearance, relief clearance, wheel dressing, radial faces on high spirals, all these important sharpening factors are under positive mechanical control, and all mechanical movements of the machine can be duplicated to assure uniformity of work on any number of pieces. The machine is equally adaptable for sharpening hobs, all makes of reamers, and milling cutters. For details write to

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'*Phone* SALE 2277 (three lines). 'Grams "BARCOL," SALE.

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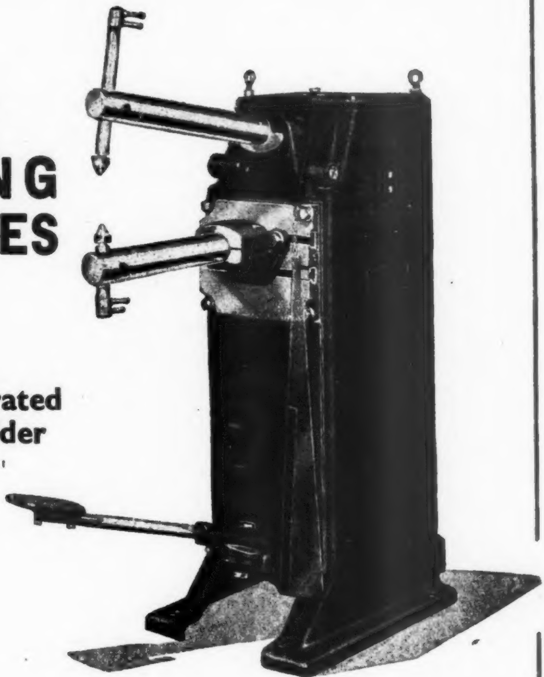

The Foot-operated Spot Welder

Capacities up to 2 thicknesses $\frac{1}{8}$ in. Mild Steel

HIGH FORGING PRESSURE: 650 lb. with 12 in. throat ensures sound forged welds instead of " cast " low-strength welds.

LOW OPERATING FORCE: Carefully matched toggle lever mechanism fitted with needle roller bearings, resulting in very low operating force being required (peak force 50 lb. at maximum pressure setting).

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All Enquiries to Our Agents

Northern Agents
MITCHELL FOX & Co. Ltd.
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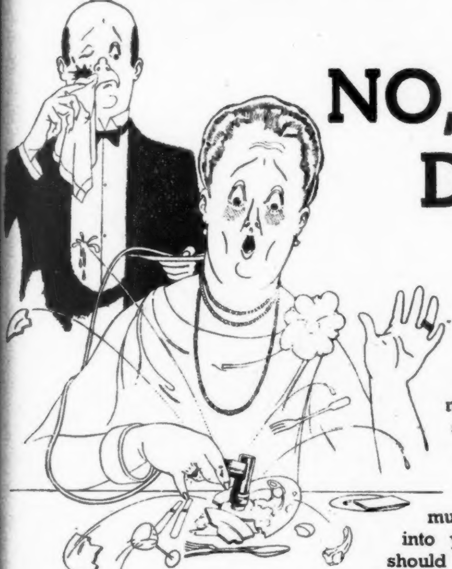
PHONE 23158-24019

ANSWERS TO DESOUTTER'S CORRESPONDENTS

NO, NO, Duchess

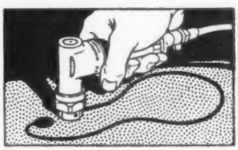


The Desoutter Nibbler wasn't made for chewing up chops and steaks. Can't your dentist do a quick repair job? Then we're afraid you'll have to mumble away as best you can, we're much too busy to get our teeth into your problem, Duchess. Or should we say your teeth into ours? Ha! Ha! (Pardon, Duchess). Had you ever eaten a meal in the Desoutter Canteen you would see the humour of that remark.

Actually, the Desoutter Nibbler is a Pneumatic Tool specially designed for cutting sheet metal, even from the centre of a sheet, if a 1" dia. hole is provided to admit the head. As its name implies, it "nibbles" its way forward cutting out a hole to any desired shape, without deforming the sheet of metal, or raising burrs on the cut edges. It is the only tool of its kind in the world.

Incidentally, it does all this with just one "tooth." So make an effort, Duchess. Keep on nibbling away. That's the motto.

P. 12. Portable Pneumatic Nibbler. Weight 2 lbs. This ingenious tool will bite its way into sheet metal at the rate of 10 feet per minute. It requires no effort to guide and with a radius arm attachment can be used like a compass to cut a perfect circle. It can also be used against the edge of a template for repetition work.

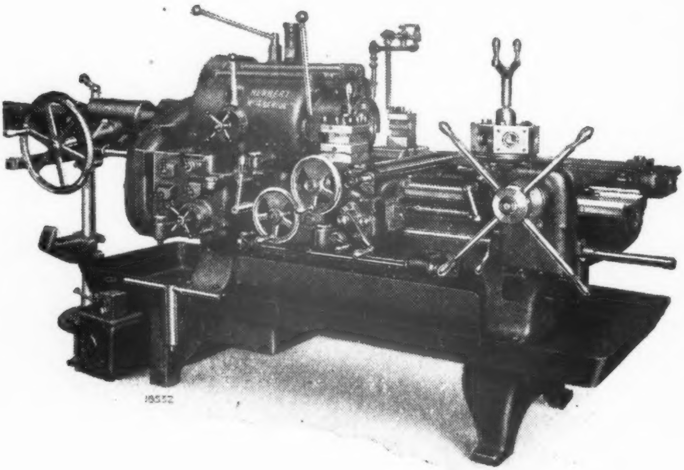


DESOUTTER . . . . *Specialists in Lightweight Pneumatic & Electric Portable Tools*

DRILLGUNS · SCREWDRIVERS · NUTRUNNERS · SHEARS · GRINDERS · COUNTERSINKING TOOLS · BOLT MILLING TOOLS · DESOUTTER BROS. LTD., DEPT. P, THE HYDE, HENDON, LONDON, N.W.9 'PHONE: COLINDALE 6346-7-8-9 'GRAMS: DESPNUCO HYDE LONDON · WORLD-WIDE REPRESENTATION

C.R.C. 122

ALFRED HERBERT LTD., COVENTRY



ON MAKING A GOOD START

WHEN new machines are first put into use it is important that reliable output figures should be obtained so that production times may be fixed on a proper basis; neither too low which causes trouble, nor too high which leads to the allocation of more machines than are necessary for a given output.

This is where we can help.

Within the limits of our capacity we shall be glad to supply schedules of operations and production estimates for any specific work. If drawings of tool layouts are supplied a small charge will be made.

Before starting a new machine send for our demonstrator, he will show what it will do and help to make a good start.

Vascoloy-Ramet

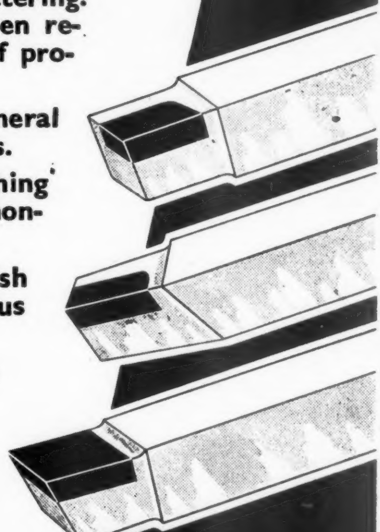
Tantalum-tungsten

CARBIDE TOOLS

The Tantalum content minimises chip wear and cratering. Ensures long life between regrinds at a high speed of production.

- **GRADE EM for general purpose work on all steels.**
- **GRADE 2A68 for roughing and intermittent cuts on non-ferrous metals.**
- **GRADE 2A5 for fine finish work on non-ferrous materials.**

ENQUIRIES INVITED FOR FORM TOOLS, CUTTERS, ETC.



- *FIVE STYLES*
- *FULL RANGE of SHANK SIZES.*

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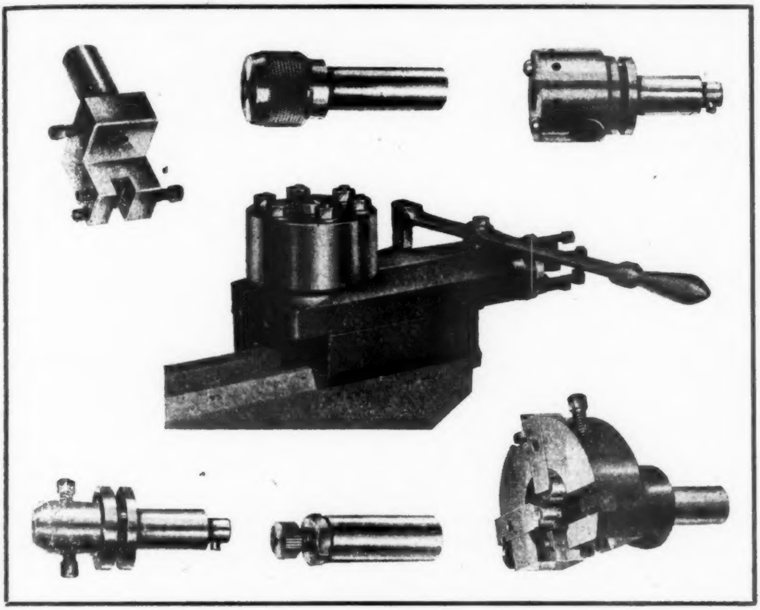
Ranking high even amongst the great achievements of Firth-Brown research, Carbide represents a great step forward in the metallurgy and development of "hard-metal" highest speed cutting tools.

The cutting capabilities of Carbide tools are so high that speed of production may now depend on the machine, not the tool.

CARBIDE

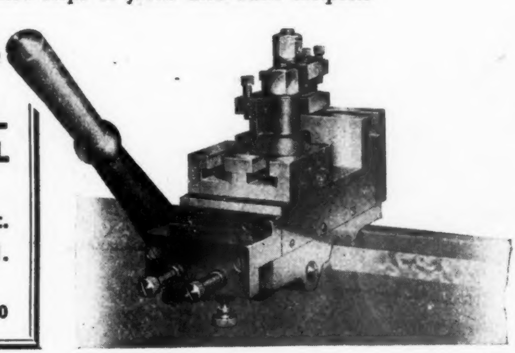
THOS FIRTH & JOHN BROWN LTD SHEFFIELD

LEVER TURRET SLIDE with TOOLING EQUIPMENT



SINGLE LEVER CUT-OFF REST

For use with Stedall, Rivett and Atlas Precision Lathes
With positive stops to front and back toolposts



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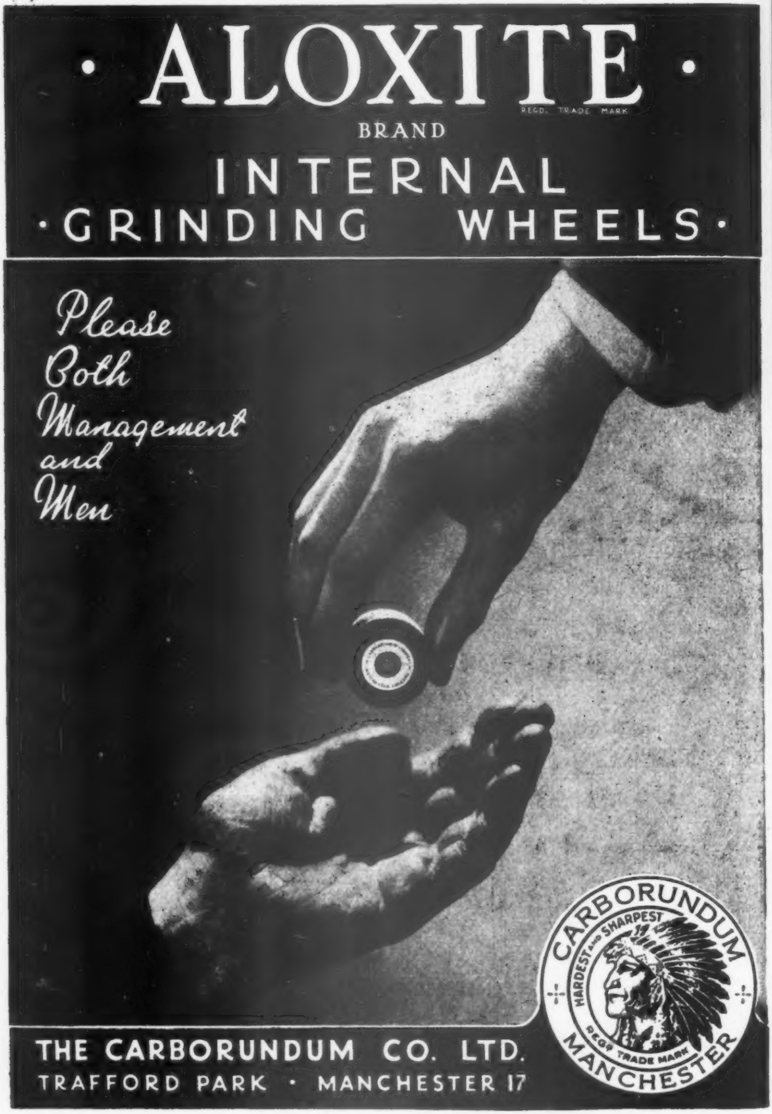
MACHINE TOOL COMPANY
147-155, St. John St.
LONDON, E.C.1.
Telephone :
CLERKENWELL 1010

Ask for Folder L5



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INTERNAL
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Please Both Management and Men
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HARDEST AND SHARPEST
REGD TRADE MARK
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V.9

High Speed VERTICAL SURFACE GRINDER

The Type " V " Surface Grinders are definitely designed for high output on series production. Centralised controls for rapid handling. Table speeds infinitely variable through hydraulic gear with patent vernier control for finishing speeds.

Capacity: 24 in. long by 8 in. wide by 8 in. **high.**

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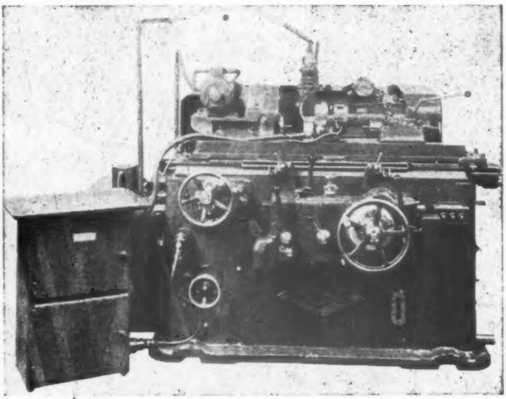
AUTO-SIZING DEVICES

The Precimax "Tymcizer" or "Precizer" may be fitted to any "Precimax" of standard type by merely plugging in the appropriate cabinet.



"Precimax" M.P.O. 5 × 18 Precizer

This also enables one cabinet to be used on any one of a battery of machines.

Particulars available on request.

JOHN LUND LIMITED

CROSSHILLS, NEAR KEIGHLEY

SPIRAL BEVEL GEARS
5 FEET
DIAMETER

ACCURATELY GENERATED
SPIRAL BEVEL GEARS
heat treated or with hardened teeth, offer you more efficient and compact drives than are otherwise obtainable.

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DIAL GAUGES
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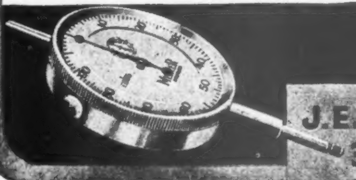
COMPARATORS, THICKNESS GAUGES, TEST INDICATORS, HAND MICROMETERS, CYLINDER GAUGES

·0001 in. ·0005 in. ·001 in. ·01 millimeters



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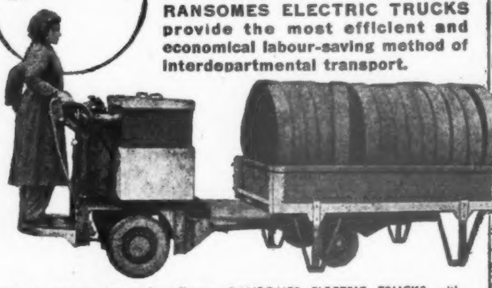
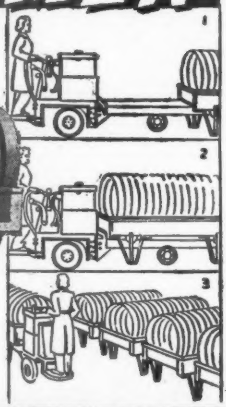
THIS TRUCK does the work of 7 MEN

RANSOMES ELECTRIC TRUCKS provide the most efficient and economical labour-saving method of interdepartmental transport.





Used in conjunction with stillages, RANSOMES ELECTRIC TRUCKS with electrically elevated platform as illustrated can be easily handled by a girl or woman and will do as much work as three or four fixed platform electric trucks. The small illustrations demonstrate the method of operation. Two tons can be picked up and dropped in five seconds, transported 400 feet per minute. *Let us send fullest particulars of*

Ransomes ELECTRIC *Industrial* TRUCKS

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BAC
STANDARDISED
DRILL BUSHES
C103
Co-operation
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IF YOUR DRILLING JIGS ARE
MADE TO AMERICAN STANDARDS
OUR BUSHES WILL
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KERAU-WUNDA
TOOL
HOLDER BITS
Made from Cobalt High Speed Steel hardened and tempered ready for grinding.
Ex stock deliveries can be given for all standard sizes.
Sanderson's make Tool Bits in three different qualities of steel: write for list and details.
Get your supplies now.
FOR
TURNING, SLOTTING
AND
PLANER TOOLS
SANDERSON BROTHERS & NEWBOULD
SHEFFIELD
LIMITED
ENGLAND

TRADE MARK

HIGGS MOTORS LTD.

GOVERNING DIRECTOR WALTER F. HIGGS M.I.E.E.

BIRMINGHAM. 6 ENGLAND

MULTI-SPEED MOTORS

These machines can be designed to give a variety of fixed speeds which are unaffected by variations in load.

This feature combined with simplicity of control and the inherent reliability of squirrel cage design make them an ideal power unit for many machine tool drives.

BIRMINGHAM, BRISTOL, DUNDEE, GLASGOW, LONDON, MANCHESTER NOTTINGHAM, PETERBOROUGH, SHEFFIELD,

The way to turn out clean work—quickly!

● The special disc valve gear in this CLIMAX CHIPPER gives such smooth control that the operator gets the 'feel' of the job at once. Starting with a few gentle taps, he can work up confidently to a very high chipping speed. The air consumption is low—and, owing to the fine precision limits to which the specially hardened moving parts are ground, the consumption remains low even after continuous hard use. This is a light, handy tool that will speed up production wherever there is chipping to be done. May we send you full details ?

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4, BROAD STREET PLACE LONDON, E.C.2.

TAS/CX 237A.

TEN MEN SAVED

by each

Douglas

INDUSTRIAL TRUCK

in your works

ONE DOUGLAS TRUCK

—will move more material than 10 men using hand trucks

—lifts and deposits oads BY ITS OWN POWER

—can be driven by a girl ALL day without fatigue

—will speed up movement of goods and work-in-progress in your Factory thereby increasing production.

Act at once

Write to-day for details :
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Cables : " Aerogal," London.
Telephone : Abbey 6210.

INDEX TO ADVERTISEMENTS

As a war-time measure the advertisement section of this Journal is now published in two editions, A and B. Advertisers' announcements only appear in one edition each month, advertisements in edition A alternating with those in edition B the following month. This Index gives the page number and edition in which the advertisements appear for the current month.

The fact that goods made of raw materials in short supply owing to war conditions are advertised in "The Journal" should not be taken as an indication that they are necessarily available for export.

THERE'S NOTHING MUCH TO IT –

But it needs the initial effort to make a start. Many factories have long delayed the tidying-up of their internal routine for lack of that initial effort — and now there are more excuses than ever. Industry has no time to stop and think : the call for output is pressing, and must be answered : perhaps, when peace comes...

BUT, NOW IS THE TIME !

and within a few short months—even weeks—further increased output can prove the value of an up-to-date Production Control technique and a planned co-ordination of all departments, while mechanization of Works routine can reduce the clerical burden and at the same time ensure accuracy and efficiency on simple clear-cut lines.

AND WHEN PEACE COMES –

there will be the legacy of a tidy house, ready and prepared to make the most of every opportunity.

"B & A SIMPLEX" and "BANDA" EQUIPMENT

Now is the time to make that initial effort. Let our Systems Department send an experienced investigator to discuss with you your production routine problems and suggest improvements. Your initial enquiry involves no obligation.

BLOCK & ANDERSON LTD.

'OLD MILL HOUSE' · TRUMPINGTON ROAD · CAMBRIDGE

Telephone : Trumpington 305 (3 lines)

Specialists in Production Control Technique and Manufacturers of Equipment for the Mechanization of Works Routine.

Branches at Belfast, Birmingham, Bristol, Cardiff, Glasgow, Liverpool London, Manchester, Newcastle, Nottingham, Sheffield, Southampton

The "Bratby" deals with every variety and size of component and whether the metal be steel or aluminium, cast iron, or bronze there is a machine and process for it. British manufacturers who are wanting a cleaner should instal a Bratby Cleaner designed to suit their special needs. Send now for full particulars of the machine suitable for your particular job, or better still, ask our representative to call for a discussion.

THERE IS A BRATBY CLEANER TO SUIT EVERY TYPE OF JOB

Sole Agents for Gt. Britain:

GEO. H. HALES MACHINE TOOL CO., VICTOR HOUSE, 1, BAKER ST., LONDON, W.1

Designed and manufactured by:

BRATBY & HINCHLIFFE LTD., SANDFORD STREET, ANCOATS, MANCHESTER, 4

INSTITUTION NOTES

May 1942

Fixtures.

May 30—Nottingham Section. Informal discussion on "Production Control," The Victoria Station Hotel, Nottingham, 3-0 p.m.

June 3—Sheffield Section. Lecture by Dr. Schlesinger on "Surface Finish," Royal Victoria Hotel, Sheffield, 7-0 p.m.

June 4—Birmingham Section. Joint meeting with the Institution of Mechanical Engineers on "The Application of Statistical Control of the Quality of Materials and Manufactured Products," James Watt Memorial Institute, Great Charles Street, Birmingham, 6-0 p.m.

June 4—Preston Section. Dinner-discussion will take place under the general heading of "Production Problems," Royal Oak Hotel, Chorley, 6-15 p.m.

June 19—Meeting of the Council, London, 2-15 p.m.

Nottingham and Leicester Sections' Works Visit.

MR. W. D. KENDALL, M.P., M.I.P.E., recently elected as an Independent at the Grantham Parliamentary bye-election, who is the Managing Director of the British Manufacturing and Research Co. Ltd., Grantham, received members of the Nottingham and Leicester Sections at a works visit to the factory on May 2. Thirty eight members attended from the Nottingham Section and thirty two from the Leicester Section. The visit was most instructive and enjoyable. At the conclusion of the proceedings, a cordial vote of thanks to Mr. Kendall and the company was proposed by the President of the Nottingham Section (Mr. Gibbons) and seconded by the President of the Leicester Section (Mr. Gimson).

Obituary.

We deeply regret to learn of the death of the following members of the Institution: Mr. L. H. Pomeroy (*Member*), Mr. A. J. Brain (*Member*) (Birmingham Section), Mr. E. Arnold (*Associate Member*), Mr. W. G. Berry (*Member*), Mr. F. W. Anderton (*Associate Member*), Mr. George Hepworth (*Member*), and Mr. J. Bishop (*Associate Member*).

Mr. Pomeroy was a prominent member of the Institution for the past fourteen years and a former President of the Institution of Automobile Engineers. Mr. Brain, who was well known in machine tool circles, had been a member of the Institution since

1925. The death of Mr. Hepworth will be deeply felt by his friends in the Yorkshire Section.

Research Department.

Mr. Mark Taylor has recently succeeded Mr. J. D. Scaife as Chairman of the Executive Committee of the Research Department.

Three important researches for Government Departments have now been completed and the reports submitted. It is hoped to publish particulars of one of these researches in the near future in the *Technical Bulletin*, as the results achieved are likely to be of wide interest and practical importance.

Intensive H.N. Certificate Course in Production Engineering.

Reference was made in our February "Notes" to the failure of the six months intensive training schemes drawn up by the Hankey Committee, particularly as regards production engineering. So far the only scheme in operation for a Higher National Certificate course in Production Engineering is the one at Loughborough College, details of which will be found in *Technical Bulletin* No. 12.

Members and affiliated firms are reminded that tuition is free and that expense allowances for those taking the course are on a reasonably liberal scale. We congratulate Dr. Schofield and Loughborough College on the lead they have given in this matter.

Addresses Wanted.

Birmingham Section : H. Corran, M.I.P.E., H. F. Varley, M.I.P.E., G. Williams, M.I.P.E., L. F. Broadbent, A.M.I.P.E., J. W. Foley, A.M.I.P.E., Edward Rees, A.M.I.P.E.

Birmingham Graduate Section : A. G. Smith, Grad.I.P.E., T. F. Wingate, Grad.I.P.E., George D. Parker, Stud.I.P.E.

Coventry Section : F. J. Marlow, A.M.I.P.E.

Glasgow Section : Alexander C. Livingston, A.M.I.P.E.

Leicester Section : Wilfred Hickman, M.I.P.E., Reginald T. Johnson, Grad.I.P.E.

London Section : A. C. Ledingham, M.I.P.E., A. A. Best, A.M.I.P.E., F. E. Bickley, A.M.I.P.E., H. F. J. Pike, A.M.I.P.E., A. Roberts, A.M.I.P.E., Frederick C. Young, A.M.I.P.E.

London Graduate Section : Hanus Bloch, Stud.I.P.E.

Yorkshire Section : Samuel Dickinson, A.M.I.P.E.

THE PRODUCTION OF MACHINE FRAMES BY THE ELECTRIC ARC

Paper presented to the Institution (Sydney Section), by John O. Ogden (Associate Member).

IN presenting this talk to-night I wish first to draw your attention to the wide ramifications of the welding industry. As you are no doubt aware the history of welding goes back many years. In fact, I know of one case where electric welding was instrumental in saving quite a large number of boiler ends which had been damaged in the flanging process. This was in 1896, the parts being built up by the electric arc using steel turnings as electrodes, and finally forging the resultant deposit in something like a reasonable

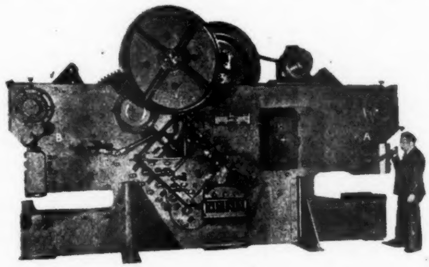

Fig. 1.—ALL-STEEL HEAVY-DUTY PUNCHING AND SHEARING MACHINE
The machine illustrated here is of exceptional interest owing to the difficulties experienced in obtaining the necessary material for its construction. The design called for side plates 20 ft. by 7 ft. 6 in. by 3 in. thick, which unfortunately were unprocurable in Australia, and further, the extreme urgency of the job precluded any possibility of obtaining the material from overseas. The problem was overcome by laminating three 1 in. plates in each side frame with exceptionally good results. This machine, incidentally, is the largest punching and shearing machine in Australia, and was designed and built in fifteen weeks.

shape. In any event the boiler ends were passed by Lloyds without comment. It is, however, only during the last ten years or so that welding has really come to the fore as a major tool of industry.

For many years welding was regarded, and to some extent still is, as merely a handy adjunct to the repair shop. This attitude was in some degree of value in that it caused the welding industry to develop on slow, sound and conservative lines, each advance being consolidated by practical application before becoming widely used or even known.

Welding in itself is a logical successor to the riveted structure, and one can call to mind many machines with steel frames in use

a few years ago, particularly in the metal working field, these machines being almost universally riveted or bolted, a particular instance being the universal punch and shear as developed originally by such firms as Henry Pels in Germany and the Buffalo Company in America.

In the literature of both these firms can be traced the gradual evolution of design from the all-riveted structure through the combined welded and riveted type of design to finally the all-welded steel machine of to-day.

The history of welding through the past ten years has been one of continuously expanding scope, new avenues being opened up almost from day to day until at the present time we have all types

Fig. 2.—ALL-STEEL HEAVY-DUTY PUNCHING AND SHEARING MACHINE —SHEAR END

This illustration shows the shear end of the machine shown in the preceding illustration and the method of laminating the three –1 in. plates is clearly seen. The fabricated gear wheel is also clearly shown.

of structural work fully accepted by the various building authorities. Large steel and concrete buildings having been erected in America and on the Continent of Europe of up to twenty storeys, not a single rivet being utilised in the whole structure. Rails are also being welded up to 2,000 ft. in length, while according to the technical literature of the railways it will not be long before rails several miles in length will be utilised thus materially assisting in developing greater speed, greater comfort, and greater safety on the various railroads of the world.

In shipbuilding also great strides are being made, in some few cases sea-going ships even the hull being entirely welded, though to the best of my knowledge no very large sea-going ships have yet been built in this manner, though tankers up to 2,000 tons have

been constructed for Great Lakes service. In addition, the superstructure of practically all modern ships is mainly welded, more and more use being made of this medium to lighten dead weight and increase cargo and accommodation space, and finally the most striking development of all, the modern all-welded rolled-steel

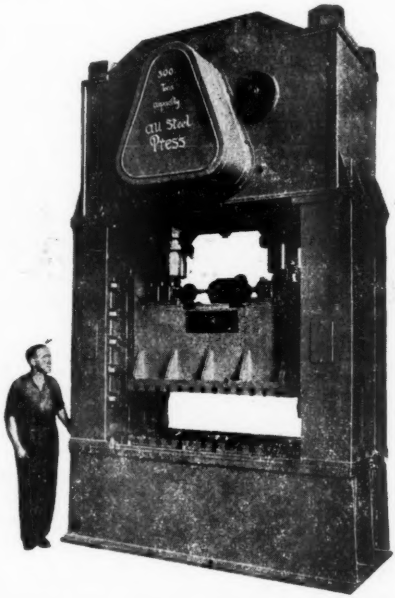

Fig. 3.—ALL-STEEL HEAVY-DUTY STAMPING PRESS

The machine illustrated here is a very heavy-duty press of the crankless type and the steel fabrication is of great assistance in allowing sufficient space to fit in gears in the crown piece, comprising as they do four complete pairs of left and right hand helical gears mounted on either side of the eccentrics. It would be difficult to see how this drive could be incorporated in a cast-iron crown piece owing to the very much heavier members which would be required. The ram is also interesting, as it incorporates a cast-steel face plate with the tee slots cast in place, while the rest of the ram is built up of rolled-steel plates.

machine tool. It is with this later field that I wish to deal to-night, not exactly from a highly technical standpoint, but rather from the aspect of more general interest.

The history of the steel machine tool has been one of gradual development and improvement. It would, perhaps, be hard to say where the idea of the rolled-steel machine frame first originated, but I am inclined to think that the Germans were the pioneers of

this type of construction with the Americans and English following fairly closely.

It is on record that considerable difficulty was experienced by the pioneers of this type of machine in convincing the engineering trade generally that this construction was possible without the extremely heavy castings to which the trade was accustomed when considering this type of machine frame.

Despite constant discouragement, however, the steel machine frame gradually forged ahead, until to-day many of the leading overseas makers of machine tools have adopted this method of construction for a very wide variety of machinery. Not only is this process now used for the construction of metal-working machinery

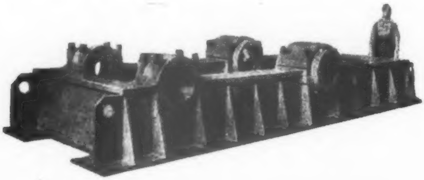

Fig. 4.—ALL-STEEL GEAR REDUCTION HOUSING

The 1,500 h.p. gear reduction unit shown in this illustration has been most successful in operation, being very rigid and entirely free from vibration, the construction of the side and end members form a one-piece box section with cast-steel bearing housings welded into place, the whole unit weighing approximately 8¾ tons.

such as presses, punches, shears, guillotines, etc., but is also used for machinery such as slotters, planing machines, lathes, and a host of other machinery.

I now propose to show a number of examples of machines fabricated overseas either entirely from rolled steel or utilising a combination of rolled steel and cast steel or cast iron.

So much for the overseas development. Developments which have been paralleled here in Australia. The firm with which I am associated commenced operations about five years ago with the object of building machinery utilising rolled steel frames, and during this period a very wide variety of machine frames have been completed by this method.

Our products have ranged from the lightest machinery right up to the heaviest type of metal-working plant such as heavy-duty plate shears, presses, rolls, etc., and it is mainly with this later type of machine that I propose to deal to-night as we have made far more definite progress in its production than in any other.

In considering the development of the rolled-steel machine frame in Australia one must remember that the market for heavy machines is definitely limited, and it was necessary to develop some method

whereby individual machines could be built at a price which could be competitive with the more usual type of stock machine which would normally be imported to fill the requirement.

The solution to this problem lay in the extensive use of rolled steel to eliminate pattern costs while the use of rolled steel also presents some very striking advantages, particularly for the heavy duty type of machine. The advantages may be summarised as follows : comparative lightness, greater rigidity, greater reliability; while at the same time from a designer's point of view it is very much more flexible than any other medium, a feature of very great importance to the Australian machine manufacturer, bearing in

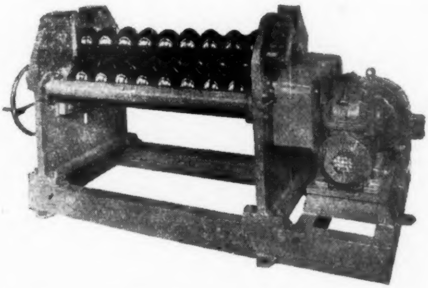

Fig. 5.—CORRUGATED METAL CURVING ROLLS

The simple little machine illustrated here is shown to illustrate the versatility and speed of construction possible when using rolled steel as a constructional medium, the machine being designed and built in three weeks from the date of instructions to proceed. It is a special machine manufactured for rolling the heavy corrugated sheet used in Anderson air-raid shelters.

mind, as remarked before, the extremely limited nature of the Australian market. In the design of welded-steel machines one must forget the technique which would be employed to construct a machine frame from either cast iron or cast steel, and must develop new methods and new ideas to obtain the full benefit of this relatively, new process, and one might say that the success or otherwise of this type of design is largely bound up in the designer, who must have not only a definite knowledge of the actual process, but must also have sufficient imagination to be able to adapt his design to the most suitable method of construction, whether it be the fabrication of a rolled-steel frame or the substitution of a cast unit.

There is quite an amount of controversy between engineers overseas as to the extent to which the rolled-steel machine frame should be detailed in the drawing office. One school maintaining that the utmost details should be shown, while the other school leans to the policy of closer workshop supervision. No doubt from

the point of view of producing repetition machinery the better policy would be to include the fullest details on the blue prints, while for more individual machinery workshop supervision would be preferable. In our own establishment we detail our blue prints fairly comprehensively, and at the same time exercise constant control in the workshop supervision. This, we believe, is an ideal method where the shop is not too large.

Fig. 6.—ALL-STEEL MEDIUM-DUTY GUILLOTINE SHEARS

The guillotine shears illustrated here is of 10 ft. by ½ in. M.S. plate capacity, and illustrates the rigidity, compactness, and neatness which can be designed into a machine when using rolled steel as a basic material, the frame with the exception of the crown piece is a one-piece unit, while the gap is 25 in. deep. The only castings used in the construction of this machine are such items as the flywheel, bearing housings, pitmans, and the taper adjusting gibs supporting the cutting beam.

In production, all plates and details are first cut and then tacked together prior to final welding, the assembly being handled mainly by a specialised man, the final welding being carried out in individual booths, the welder having but little to do other than the straight out welding of the structure.

The question of the type of electrodes used and the number of runs is one which is decided in relation to the particular job under review. In the main it is our policy to utilise the largest possible electrode. In the case of heavy fillets we utilise an 8-G rod as a filler in the corner then follow with a run of $^5/_{16}$ in. or ¼ in., care being taken, of course, to minimise distortion.

With regard to annealing the finished structure there appears to be a good deal of doubt. Many leading fabricators differ as to the necessity of this practice or otherwise. Our own experience suggests that while certain structures are greatly improved by annealing in the majority of cases it is not really necessary, providing, of course, correct welding technique and efficient design are utilised.

Discussion

MR. C. CRANE (Section President) who presided : Can you give us an idea of the relative weights of steel and cast-iron presses or guillotines having the same rigidity ? In the designing of guillotines, strength is an important factor, but probably the most important is rigidity, and in order to get that considerable masses of cast iron are necessary. I would be interested to know what is the comparable weight of a steel machine of the same rigidity as one of cast iron ?

MR. OGDEN : The answer is largely bound up in the design of the machine. An incorrectly designed machine of steel might weigh something in the vicinity of one of cast iron, but a correctly designed steel machine would be approximately 40% lighter than a cast-iron job. That is borne out by quite a number of illustrations shown to-night. So far as rigidity is concerned, that Cincinnati job which was illustrated weighs probably half that of a machine made of cast iron.

MR. OLIVER : With regard to the photographs you showed us to-night, you did not give any examples of the use of tubing. Is it not used on account of its high tensile value to get rigidity and lightness ?

MR. OGDEN : I certainly did not show you any illustrations to-night. Tubing is used largely overseas in machine design. I cannot call to mind at the moment any particular instance, but it is used to a considerable extent.

MR. DUNK : Why do you use a box beam in the design of your guillotines ?

MR. OGDEN : The principle involved there is the stiffening of the sliding cutter beam. In the majority of guillotines, a heavy fish-backed beam is utilised to get the necessary rigidity. When the blades are slightly blunt, great pressure is exerted backwards in addition to the actual cutting pressure, and that is a cause of trouble. In the machines I illustrated, the pressure is taken on a fixed beam, and not on a sliding part. This can be designed to give absolute rigidity, the result being that there is no possibility of spring between the blades during cutting. We have installed machines which illustrate the value of this principle. They have been working for upwards of two years and we have never ground the blades—which proves that rigidity in a cutting blade is absolutely imperative.

Answering another question, Mr. Ogden replied : The question of movement is to some extent bound up in the design of the mach-

ine, but there has also to be considered the technique adopted when the material is fabricated. If a member is incorrectly welded there is a possibility of movement taking place, but provided the design and technique adopted were correct, there would not be sufficient movement to be of danger in the actual operation.

CHAIRMAN: To what extent have you found it necessary to anneal structures after welding? Is it generally advantageous to do so?

MR. OGDEN: It is definitely advantageous in some cases, particularly with fairly long beams. In the majority of presses and guillotines, box section frames are adopted, and there is little need to pay much attention to annealing in this case. In fact, the Lincoln Company in America, one of the leading firms in that type of work, strongly advise against annealing, but it is distinctly advantageous in certain beam designs.

MR. LANGMEAD: How do steel bearing faces compare with cast iron?

MR. OGDEN: Steel bearings are probably a little more expensive than cast iron or bronze, but the latter have to be used for sliding bearings. It is not possible to run a steel face on another steel face. It would certainly seize.

MR. LEE: Are those frames completely tack welded together and then welded, or is each component part completely welded together first?

MR. OGDEN: The technique of construction is largely considered on each individual job, but in the majority of cases it is usual to tack the various parts together fairly securely and then weld. It has the advantage of obtaining better production, as one man is always responsible for the assembly. Welders have only to weld the structure, and very few men are capable of assembling an intricate structure without much supervision. That is why it is better to have one man tacking the components together.

MR. LEE: What is your opinion of the relative merits of using big rods and one single layer of weld, as against using smaller gauge electrodes and multiple runs?

MR. OGDEN: In the majority of our machines I suppose 70% of the rods we use would be four-gauge. We use a certain amount of six-gauge and possibly some eight-gauge. For a heavy job we might use $^5/_{16}$, but that is required in very few cases. On the question of multiple runs, a single run is quicker and, in the majority of cases, where correct design is embodied it is not necessary to do a multiple run.

Proposing a vote of thanks to Mr. Ogden, MR. MCPHEE said : I must compliment Mr. Ogden on the way he handled the situation which arose through the failure of the lantern. I presume that one effect of that was to curtail the descriptions of the machines he illustrated, and that otherwise we should have heard more about the production of welded frames. However, a great deal of information on that subject came out during the discussion which took place after he had finished his address. I have much pleasure in proposing a vote of thanks to Mr. Ogden, and congratulate him on the way in which he handled his subject and the clear explanations he gave.

The vote of thanks was carried by acclamation.

THE ELECTRODEPOSITION OF METALS

Paper presented to the Institution, Edinburgh Section, by Stanley Murray

Historical Review.

PLATING usually means the covering of a base metal with a rare one. Until recently this was mainly for decorative value, and so far as gold and silver are concerned has been practised for centuries. It is known that as far back as 3,000 B.C. the Egyptians had a method of plating which depended on the beating of gold into foil, but like most things the Egyptians did, no one can tell what the whole process was. The next development was that of suspending finely powdered gold or silver in a suitable vehicle which, though still practised to some extent to-day, is by no means satisfactory. Following this came the fire or amalgam method which was used in a somewhat crude form as far back as 300 B.C. and was the real forerunner of modern plating as the coat formed was fine and also adhered to the base metal. In this method the surface to be plated, usually brass or copper, was first treated with a solution of mercurious nitrate and then rubbed with an alloy consisting of nine parts of mercury to one part of gold. After the surface had been thoroughly amalgamated the mercury was expelled by heating, leaving a smooth deposit of gold. The process could be repeated as often as desired to give heavier coats. As has been said, the finish was remarkably good and is still used even to-day as there are people who maintain it is superior to that obtained by modern methods.

Coming nearer the present we find a different system being developed. About 1743 Thomas Boulsover introduced what was called the " fusion method " which consisted of heating a slab of copper with a thinner sheet of silver, both being tightly clamped together, to nearly fusion point and rolling out the compositive slab into a sheet from which the required articles were fabricated. This ultimately became known as " old Sheffield plate." This method was used until about 1840 when a young surgeon, John Wright of Birmingham, discovered that dense uniform adherent coatings of silver could be deposited by passing electricity through a cyanide solution of silver, and so *electro-plating* was born and advances were fairly rapid. Following on silver came gold, as this metal also readily forms cyanide salts. *Copper* came next from sulphate

November 22, 1941.

solutions followed later by a cyanide electrolite. *Nickel* was deposited, about the eighties, and tin, zinc, cadmium, and chromium in still more recent years. To-day it is safe to say that every metal can be deposited electrolitically and some non-metals as well, e.g. rubber, which process has become a commercial proposition.

Many difficulties had to be overcome and even to-day there is room for advancement. Chrome is a typical example, for although it was in 1852 that C. J. E. Junot took out a patent for the electrodeposition of chromium, much research had still to be done, and it was only in 1905 that Carveth and Curry laid the foundations of modern chrome plating. Even then it did not become a commercial proposition till 1925. Thus we have a brief sketch of a growing modern industry which has developed from almost a black art to a scientific process.

The Theory of Electrodeposition.

The theory of electrodeposition, like many other theories, does not always hold good in commercial practice, but the main points are well worth noting. Usually electrodeposition involves the reduction of a metallic compound dissolved in water. There are some exceptions, but they are more or less curios, such as the depositing of aluminium, in which case the salts of the metal are dissolved in a non-aqueous solution.

When the salts of a metal are dissolved in water ionisation takes place. In other words, a certain percentage of the salts dissociates into minute groups of atoms termed ions. These ions carry a small electric charge. The metallic ion holding a positive charge and non-metallic ion a negative charge, so that when a current is passed through the solution the positive ion travels to the negative pole or cathode and the negative ion to the positive pole or anode. As was stated, only a percentage of the salt ionises, and this percentage varies with the concentration of the solution. In a weak solution this may be as much as 50% ionisation, but as the solution becomes more concentrated the percentage falls. It is this property of ionisation of salts on which the foundations of electrodeposition rest.

The second important item is "Faraday's" law which, as far as the electroplater is concerned is, firstly, that the quality of metal deposited is proportional to the current employed and the time for which it is flowing. Secondly, that the weight of metal deposited is proportional to its chemical equivalent. The chemical equivalent is found by dividing the atomic weight by the valency. The valency is the number of electrical charges carried by each ion and is always a whole number, e.g. the atomic weight of cadmium is 112.41 its valency is two, thus the chemical equivalent is 56.205. Some metals

form two or more series of compounds in which the valencies are different. Take copper which forms cuprous salts valency one and cupric salts valency two, thus it can be seen that if solutions were made of the two types of salts the first should deposit twice as much metal per ampere hour as the second. This is a case where theory falls down in practice. The reason will be dealt with later.

Mechanism of a Plating Bath.

Now let us look at the mechanism of a plating bath. In most cases we have a solution of a salt of the metal to be deposited and hanging in the solution an anode of the metal. Our cathode is the article on which we wish to deposit. To the anode we connect the positive lead of our electric supply nearly always a generator, though metal plate rectifiers are finding increasing use and to the cathode our negative. When the circuit is completed current will flow and the positive and negative ions will be set in motion, the positive flowing to the cathode where it looses its charge and deposits as a metal. The negative moves to the anode where it dissolves an amount of metal and again becomes a salt going back into solution and dissociating again, e.g. the copper sulphate solution. In solution the salt CuSO4 splits into Cu and SO4, the copper ion travels to the cathode and deposits copper, the SO4 travelling to the copper anode where is dissolves off the equivalent amount of copper again forming CuSO4. But again difficulties arise, the speeds of the ions are totally different and are very slow, so that the solution may become impoverished with metal at the cathode and too rich with metal at the anode. This is known as polarization. The result being that a greater potential is necessary to pass the required current through the solution as metal will not deposit so readily from a weak solution, nor will it dissolve from the anode quickly in the strong solution which is formed there. In practice the balance is kept more even by agitation of the solution and also with the frequent removal and immersion of articles in the tank. A well-balanced solution should invariably keep a steady density, additions of salts only being needed to replace drag-out losses. The above is applicable to all solutions, but again is not always the method followed in practice, as different metals have different reactions and properties which are not always desirable. As can be imagined, plating solutions like all other machines are not 100% efficient, some have an efficiency of 85% and others only 10 to 15%. Electrolysis is always taking place, hydrogen being given off at the cathode and oxygen at the anode, some of the current dissipates as heat, etc.

Every solution has different properties and must be treated as a separate item, but one thing that is common to all solutions is what is known as throwing-power. The metal deposited does not spread on evenly, all sharp edges attract a larger amount of metal than

plain flat faces, this being due to the fact that the current density is always greater on a sharp point or edge than on a rounded one. Akin to this, all prominent parts or parts nearest the anodes receive more than their share of current passed and therefore attract more metallic ions, as all solutions obey Ohm's law and the further the current has to travel the greater the restivity. This is of great importance when a required thickness of metal is desired and there is no end to the methods developed to try and overcome this difficulty. One of the most successful is anodes made to conform to the shape of the articles, another is to place the article as far from the anode as possible so that the ratio will be small, but this entails a longer period for deposition of coat.

From the foregoing it can be seen that the ideal solution should (1) contain a large proportion of metal, (2) should have good conductivity to reduce energy absorbed in the process, (3) must be stable to the metal which is to be plated as well as the air, though this qualification is not met by cyanide solutions which are continually decomposing with the evolution of hydrocyanic acid and accumulations of carbonates, (4) should readily dissolve metal from the anode, thus keeping the solution rich, (5) should produce regular and adherent deposits, (6) throw well, (7) if possible all the above should be contained in a comparatively simple solution.

Metallic compounds are not usually good conductors. To overcome this, other salts are added to plating baths which dissociate freely and thus aid the conductivity of the solution. For this purpose sulphates and chlorides have been used, but what addition agent is used must depend on its reaction in the bath. You cannot use sulphates in a cyanide bath nor can sulphuric acid be used in large quantities in a nickel solution, which is essentially a slightly acid bath, but is found very beneficial in the copper sulphate solution. The question of addition agents in plating is being studied with great care at present, both in this country and in America, and some very valuable data has been obtained which may in time improve the structure of electrodeposited metals and increase the speeds o deposition.

The theory of plating is becoming an absorbing study and some very interesting books have been published about it, but the foregoing main principles will be found useful when considering the plating of the metals most commonly deposited. It will be as well now to give a short account of the preparation before electroplating, as on this rests the whole success of a well-plated article no matter how good the plating bath may be.

Preparation before Electroplating.

All articles to be plated, whether they have previously been polished, ground, machined, pressed, or extruded, must be made

chemically clean. The most minute particle of grease or oxide film will spell disaster.

The first process is to clean off all grease. Two types of grease materials have to be recognised, mineral greases and oils, and fatty compounds which include oils and fats of vegetable and animal origin. The plater cannot possibly tell which may be present and so must treat all articles in such a manner that both will be destroyed or removed. In common practice two degreasing processes are used. To remove all heavy greases " trychlorethylene " is the most popular. With this degreaser the articles are suspended in the hot vapour which condenses on the cold work carrying the dissolved grease away in the condensed solution. Many safeguards have to be taken with this liquid, as breathing the vapour will render the operator unconscious also, the liquid is expensive and care must be taken to see that as little as possible is lost. Modern plants are comparatively safe and some are very ingeniously designed. Other liquids can be used, for instance " carbon tetrachloride," " petrol," or " benzine " but the last two are seldom ever used due to the great fire risk. The next process is usually an alkaline or potash cleaner which reacts on the fatty compounds by converting the insoluble compound into soluble components, usually soap and glycerine. For this purpose American potash was universally used, but is fast falling out of favour for modern chemical cleaners which do not attack the hands of the operator. Modern solutions usually contain a mild alkali and an insoluble salt, the purpose of the insoluble salt being that since the cleaner is used boiling, it gives a scrubbing action on the work, acting much in the manner of a sandblast. A typical modern formula is sodium carbonate and sodium silicate with a small percentage of strong alkali, usually sodium hydroxide. The sodium hydroxide forms soaps with the saponifiable grease, which in turn helps to emulsify the unsaponifiable grease ; sodium carbonate is used, as emulsification will only take place in a slightly alkaline solution. These cleaners are often used with electrical current, the work being cleaned acting as the cathode and is thus scrubbed by the abundant evolution of hydrogen.

After these cleaning processes it is necessary to see that all oxides are removed. With brass, copper, and bronze, a dip in a weak solution of potassium cyanide is usually sufficient unless of course the oxide is very heavy like the skin formed on brass which has been extruded. Then it is necessary to dip in " aquafortis " which is a mixture of nitric and sulphuric acid containing a chloride, usually common salt. The next operation is often a hand scouring one using pumice powder. This not only helps to remove any solids but roughens the surface of the metal, thus forming a sort of keyway to which the plated metal will adhere strongly. Hand scouring is still used

extensively, though electrolytic cold cleaners have been produced to take its place, their purpose being to impart a very fine etch to the work and clean off any remaining grease, but they have their limitations, as they dissolve solder and lead alloys, which is detrimental. If the plating has to be done in an alkali bath a cold water swill is all that is necessary, but if the bath is acid or slightly acid, a dip in 10% sulphuric acid is needed to neutralise the alkali. Steel and iron are treated differently being electrolytically, etched in an 80% sulphuric acid bath that is, if the finish is to be highly polished, but if the deposit is to be heavy, such as is used in hard chrome and heavy deposition of nickel, then a much deeper etch is required and 30% sulphuric acid is used. Of course, it must be understood that during all the above processes everything is thoroughly washed in cold running water on removing from one bath and before immersing in another.

Cleaning is very important and plenty of time and care must be taken, as all metals must be treated differently in themselves and each metal in yet a separate way depending on what plating process has to be done. It can be safely stated that 90% of all faulty work can be traced to bad or careless cleaning. Just how much care has to be exercised can be understood by the fact that a well cleaned article has turned out faulty just because it touched the outside of a plating tank when being immersed.

So much for cleaning. Let us see what types of metals are most commonly deposited and what their uses are.

Rhodium.

This rare metal is deposited from a sulphate bath containing ammonium sulphate operated at 50°C. at a current density of not exceeding .6 amps per square inch, the maximum thickness of coating is approximately 0.00001 in. It is used mostly in the jewellery trade for plating over silver to keep it from tarnishing. Its only commercial use is for 'phone contacts and for plating over silver and copper for use as reflectors. It is unaffected by strong acids and alkalis and atmospheric corrosion. Is very expensive.

Gold.

Deposited from a cyanide solution using potassium or sodium cyanide as an addition agent. Mostly used as a decorative finish for jewellery work and can be built up to any thickness required. In commercial use it is applied to 'phone and electrical contacts in delicate instruments. Being a noble metal it does not offer any protection to a base metal. By adding silver, copper, or nickel to the solution it is possible to plate red, green, and white golds, which are of great decorative value.

Silver.

Deposited from a cyanide solution in which a small percentage of carbonates are used as addition agents to give the best results. Silver tarnishes readily and finds its greatest use for plate ware, but is extensively used for contacts and reflectors. It can be plated to any required thickness but must be removed from the bath and scratch-brushed every now and again to even off the tendency to roughen. The coat is adherent and is a good protection to brass and copper if heavily deposited. By adding certain solution such as carbon disulphide or a mixture of one gm. of sodium thiosulphate plus 10 cc. ammonia per litre of solution, the deposit can be plated fairly bright.

Articles placed in silver solutions tend to get a deposit by immersion, which is undesirable, as such coats are not adherent, and so the current must be switched on at fairly high amperage before any work is placed in the tank. This is known as striking. After striking, which is usually done in a separate vat, the work is plated at the normal current density of three to six amps. per square foot. Fine silver anodes must be used as sterling silver contains 7.5% copper.

Zinc and Cadmium.

These metals are both very much alike in appearance and chemical behaviour, and are used in industry solely for the protection of steel and iron from corrosion. Their merits are as follows.

Electroplated zinc has many advantages over hot dip coatings. (1) There is no great rise in temperature, galvanizing being done at 460°C. which quite often distorts the metal being coated. (2) Protection value is the same for a given thickness of coat. (3) It has much better adhesion to the basis metal there being no interlayer of alloy and therefore will bend without cracking, the coat is soft and in the case of rivets enough metal is left on the head to prevent corrosion for a considerable period. (4) Paint will not adhere to hot dip coatings but will to an electrodeposited one. (5) With a chemical bath the control of the structure can be maintained and much more even desposits obtained. Perhaps the greatest advantage is that there are no blobs and filling up of threads on fittings, which is very important.

Cadmium has all the above advantages, but gives greater protection, as it does not corrode so readily as zinc as long as the film remains unbroken. Both these metals are electronegative to iron and thus prevent exposed areas of iron from rusting at their own expense. Now, since the potential difference between cadmium and iron is less than that between iron and zinc, cadmium will not protect such large exposed areas as zinc.

It has been proved that with coats of these two metals, having the same thickness and produced under the same condition, the cadmium will protect three times as long as the zinc, as long as the coat remains unbroken.

Disadvantages of cadmium are its price and that it cannot be used near foodstuffs. Nevertheless, its use has come greatly to the fore in recent years, especially in the aircraft industry and for marine work, as salt spray hardly affects it.

Zinc is plated from both acid and cyanide baths, the cyanide bath having the best throwing power. A common acid solution is as follows.

Zinc sulphate 150 to 300 grs. per litre used at a Ph of 3.5 to 4.5. (The Ph of a solution is a measure of acidity or alkalinity measured as the hydrogen ion concentration). Addition agents used are sodium acetate or aluminium chloride as buffers and ammonium or sodium chloride to improve throwing power. Current density 14 to 28 amps. per square foot. The cyanide bath—zinc cyanide 30 to 60 grs. per litre with an excess of potassium cyanide and sodium hydroxide. Temperature being 40° to 50°C. and current density 19 to 28 amps. per square foot.

No great success has been obtained with acid cadmium solution. The cyanide is therefore nearly always used and contains cadmium cyanide and potassium cyanide operated at nine to 47 amps. per square foot at room temperature or slightly heated. Much brighter deposits can be obtained by adding nickel sulphate and Turkey red oil in small quantities, or lactic acid.

Tin.

Tin does not offer such great protection for iron and steel as zinc and cadmium, but has the advantage that it is non-toxic and can be easily soldered. It is soft and can be bent and drawn without breaking the skin. Until recently it was solely applied by hot dipping, but for certain classes of work the hot dip coating is not heavy enough, approximately .001 in. is the maximum except where blobs are formed, whereas the electrodeposited coat can be built to any thickness and adhesion is just as good if not better than hot dipping. It is plated from either an acid or an alkaline solution. The alkaline solution is mostly used to-day, the most popular solution being the stannate which, though it has to be very carefully controlled, gives heavy white deposits in a fairly short time. The amperage ranges from 15 to 20 amps. per square foot. Solution 85 gms. of tin in the form of sodium stannate with from 15 to 20 gms. of sodium hydroxide. The hydroxide is necessary to stabilise the solution, as stannate tin readily reverts to the stannite which would deposit in solution and make the deposit black and coarse. The

solution is sometimes used with insoluble anodes, nickel being used, for when tin anodes are in the vat great care must be taken to see that the tin dissolves as stannate and not stannite. In this case the tin is replenished by additions of sodium stannate.

Electroplated tin is used on electrical contacts and bolts and nuts, etc., where hot dip coatings are not always suitable. Quite a number of semi-rotary pumps are tinned electrically. It can be deposited on iron, steel, brass, copper and their alloys.

Copper.

Deposited from two solutions, the cyanide and the acid electrolytes. The acid or sulphate bath is most commonly used, being easily worked and simple of construction, as it contains only copper sulphate and sulphuric acid, and is used for all heavy deposition such as electro-forming and electrotyping. It has a wide working range, and with heating and agitation very high current densities can be used, even as high as 93 amps. per square foot, but care must be taken, as the tensile strength and appearance of the coat vary with the temperature and the current density. Copper is usually used when plating non-metallic substances, e.g., wax patterns for gramophone records and plating of plaster of paris moulds, etc. The sulphate copper is also used for copper refining and even for the manufacture of copper tube. Its great disadvantage is that with iron and steel copper will deposit by immersion, thus causing porous spongey deposits which do not adhere to the base metal, so that all iron must be deposited with copper first in the cyanide bath before transferring to the acid.

The cyanide copper is much more limited in its use, and though it deposits twice as fast as the acid copper, for the same current, the limits are ever so much finer, as the metal ion concentration is very low and the maximum current density is only about 14 amps. per square foot.

This solution has its own special uses, since the deposit is very fine grained and free from pores. It is used for protecting steel parts which are to be cyanide hardened or carburised and yet require certain parts to remain soft. A deposit of 0.002 in. is sufficient. It is also used for all purposes where a thin deposit of copper is required.

Nickel.

Modern nickel solutions have all the same basic composition, nickel sulphate and chloride and boric acid. There are various other addition agents and by careful control of the solution and its constituents the mechanical and physical properties can be varied. Thus we can produce a smooth soft white deposit, or fairly

bright hard deposit. There are numbers of nickel solutions which plate bright and therefore eliminate the necessity of polishing the deposit. This is only for decorative work, and is used in all automatic nickel, chrome plating plants. For decorative and protective work a fairly soft deposit is used, as it will polish more easily and thus save reducing the thickness of the coat.

Nickel offers very good protection to iron, steel, brass, copper, and quite a variety of other metals. The thickness for iron and steel is recommended at over .001 in. For non-ferrous metals this can be reduced to .0005 in. as long as the deposit is adherent. I have seen deposits greatly in excess of this failing, as the coat was not fully adherent to the base metal and had pit marks in it which, therefore, permitted moisture to get in and start corrosion.

The most important use for nickel at the present is for the building up of worn or over-machined parts. For this purpose we use a solution that will deposit fairly hard and one that has exceptionally good adhesion properties, also builds fairly evenly and slowly. There is not space to go into all the details of the process, which is a subject in itself, as there are such things as the stopping off of the untreated parts, the different types of etches for the various alloys of steel, the current densities to be used and the positions of the anodes, as the solution is not a very good thrower. Nickel built up in this way is machinable, has good wearing properties, Brinell hardness up to 550 and, most important, it adheres well to the basis metal. Occasionally jobs will turn out faulty due to being too long in the atmosphere when coming from the final etch. Thirty seconds is the maximum allowed and this includes the last wash with water. If the forging is heavy its temperature must be as near that of the solution as possible before the current is switched on, or burning will take place, and though the deposit will look right it will strip off during machining. There are many difficulties to be overcome and experience is the only guide that we have at the present.

Any thickness can be obtained. I have seen deposits up to $^1/_{10}$ in. and the process is recognised by Admiralty for repairing under machined parts, i.e., breech rings (weighing from a few lbs. up to cwts.), gun barrels, shafts, bushes, and no end of other things. Just as a point of interest, when the *Thetis* was salvaged it was found that the only parts that had not corroded were those parts which were built up with nickel.

Chrome.

Following on nickel there is chrome. This metal is the hardest and until recently was only used for alloying with ferrous metals, and was of no other use until it was found that it could be electrodeposited. Until a few years ago it was plated only as a decorative

finish, mainly on to a polished nickel surface, as chrome will not tarnish while nickel does. Also, chrome is one of the noble metals and therefore does not protect base metals from corrosion, and so is only used as a veneer over nickel. It is well known in its decorative form and no description is necessary.

The solution has not changed since its plating became a commercial proposition. It contains chrome anhydride CrO3 and a sulphate usually sulphuric acid in the proportion of 100 to one. The rate of deposition is slow, since in this form its valency is six and the thickness for decorative work is only in the region of .00005 in., the solution worked at 110°F. with current density of 60 to 80 amps. per square foot. The deposit is bright and does not need any finishing.

The most interesting side of chrome plating is what is known as hard chrome. The solution is much the same composition as for bright chrome, but the temperature is higher and the current density is anything from two to four amps. per square inch. Care must be taken to see that the temperature does not rise with the passage of such heavy currents, as the hardness of the deposit depends on this.

The adhesion of hard chrome is excellent and far superior to that of nickel, as from the nature of the solution any oxide film, which may be left by accident, is dissolved by the strong acidity of the chrome electrolyte. With well-treated articles it has been found impossible to separate the plated coat from the base metal no matter what thickness of coat has been deposited.

It is as well to state here that hard chrome is deposited on the basis metal direct without any intermediate coat of nickel or copper, and any thickness can be deposited provided the process is carried out with due care and attention to all small details, such as, guarding of sharp edges from high current densities found there.

Hard chrome is coming more to the fore since the outbreak of war, as parts subject to heavy wear are being treated in this manner, and the hardness of chromium surpasses that of any known hardening process, comparative figures being over 1,200 Brinell or Rockwell hardness of 68 to 70. It cannot be machined and must be ground. The grinding speeds must be watched, as too high speeds will result in the chrome grinding the wheel away.

It has been the practice in the past to use fairly heavy deposits of chrome and grinding down to size, but equally satisfactory results can be obtained from thin deposits. If the article to be treated is ground to within .002 in. under size, it is possible to build up with chrome dead to size and ready for fitting, but anything over .002 in. must be ground. Large quantities of work are being treated with as little as .0005 in. and found to outlast the life of the machine.

There is much to be said for thin desposits, as electrodeposited chrome is very porous and these pores act as traps for lubricants, but in a ground coat most of these pores are filled in, thus destroying this valuable asset. The cost is very much reduced in both the plating and the saving of the extra grinding, which is usually costly due to heavy wear on the wheels.

Hard chrome has a big future and any type of metal can be treated, unlike other hardening processes which apply only to ferrous metals.

Aluminium and its Alloys—Anodic Treatment.

Before closing it would be as well to give a short account of a process allied to electrodeposition, namely, the anodic treatment of aluminium and its alloys.

Aluminium and its alloys tend to corrode very rapidly, and with the increasing use of these metals it is of first importance to prevent this. In anodic treatment an oxide film is formed on the surface, which resists any further corrosion and is perfectly homogeneous. This film is hard but ductile and therefore prevents excess scratching of the metal without impairing its quality.

An interesting point about this film is its property for absorbing analine dyes, thus making it possible to produce articles from which the colour will not chip. Use is being made of this property at present but its future is in peace-time manufacture. The film is also an excellent base for painting.

Anodising is the reverse process from plating. In this case the articles are made the anode in the electrolyte, the cathodes usually being steel or lead, depending on the process in use. The most favoured process is the chromic acid solution, which in this country is usually recommended for use as 3% chromic acid in distilled water. The voltage is stepped up at intervals during the hour treatment from none to 50. In America solutions are used containing 5% to 10% chromic acid and treatment is for thirty minutes at a steady 40 volts. The other popular solution is 20% sulphuric acid, which has a treatment time of thirty minutes at between 10 and 20 volts. Many more details could be given, but for interested parties there are many sources from which information can be obtained.

Research Department: Production Engineering Abstracts

(Edited by the Director of Research)

NOTE.—*The addresses of the publications referred to in these Abstracts may be obtained on application to the Research Department, Loughborough College, Loughborough.*

ANNEALING, CASEHARDENING, TEMPERING.

Hot-quenching of High-speed Steel, by Robert Hughes McCarthy. (*Mechanical Engineering, U.S.A., March, 1942, Vol. 64, No. 3, p. 201, 8 figs.*)

As a result of a research on the hot-quenching of 18-4-1 type high-speed steel, certain facts have been developed concerning the kinetics of austenitic transformation, as well as data on the hardness and toughness, resulting from various hot quenches. Type of furnace used in investigation. Check tests of equipment. Results of investigation. Heating-cooling curve from magnetic test. Austenitic transformation of 18-4-1 high-speed steel based on magnetic change (1) 350 and 400 F quenches, (2) 700 and 900 F quenches, (3) 1,050 and 1,150 F quenches. Quenched and tempered hardness of 18-4-1 high-speed steel. In an attempt to determine the practical aspects of hot-quenching methods, a series of lathe breakdown tests and Charpy impact tests were conducted. There are two modes of austenitic transformation, with the line of demarcation occurring somewhere between 975 F and 1050 F. There is a slight trend toward a decrease in tool life with an increase in quenching temperature. The high-temperature quenches result in better lathe tools.

COOLANT, LUBRICANT.

Regeneration of Used Lubricating Oils, by K. Thomas. (*Z.V.D.I., Vol. 85, No. 2, January 11, 1941, p. 33*).

Prior to the war the consumption of lubricating oil for German transport engines amounted to about 100,000 tons a year, excluding oil used by the army. About one-third of these requirements were met by regeneration of used oil. The author describes the five principal stages of regeneration, viz. (1) Separation of deposits including water and sludge by filtration, (2) sulphuric acid treatment, (3) neutralisation and preliminary bleach, (4) distillation of neutral oil in vacuum, (5) final bleach and filtration, together with the control tests. It is stated that the regenerated oil is fully equivalent to fresh oil and will give identical service, obviously the regenerative treatment will vary with the nature and employment of the original oils, and thus transformer oils, machine tool oils, and engine oils will require separate collection and treatment. In this connection the provision of special tank wagons calling at works and garages throughout the country has been found well worth while, as this saves the needless transit of metal containers to the refinery. In the author's opinion, the proportion of regenerated oil available to the industry will rise, as the organisation of collecting centres and provision of special refineries is extended.

(*Communicated by the D.S.I.R., Ministry of Aircraft Production*).

ELECTRICAL ENGINEERING.

Machine Tool Electrical Standards—III and IV. (*Machinist, the Machinist Reference Book Sheet, April 11, 1942, Vol. 85, No. 55, p. 1,339, 2 figs.*).

Standards governing electric motor and control equipment for machine tools were adopted by the National Machine Tool Builders' Association, Cleveland, Ohio, on September 5, 1941. Control. Opening of circuits. Protection. Circuit testing. Inclosure.

Starters for Electric Motors in Workshops, by James F. Driver. (*Machinery Lloyd, April 4, 1942, Vol. XIV, No. 7, p. 39, 5 figs.*).

Service conditions are decisive. Slip ring, squirrel cage and pole changing types. Simple starter for three-phase slip ring motor. Star-Delta starter switch for squirrel cage motor. Connections of drum type Star-Delta starter. Connections of simple starter for single-phase induction motor. Starting problems are less acute with direct current motors because these have a high starting torque and a suitable choice of the resistance will ensure full load torque on the first contact of the starter. Overload devices.

EMPLOYEES, WORKMEN, APPRENTICES.

An Approach to the Problem of Foreman Training, by H. W. Locke. (*Labour Management, April, 1942, Vol. XXIV, No. 259, p. 56*).

Foremanship to-day. A pivotal man in industry. Details of training scheme. Follow-up courses. The value of foreman training.

Detecting the Accident-prone Worker, by C. A. Drake. (*Personnel, U.S.A., March, 1942, Vol. 18, No. 5, p. 276*).

"Unavoidable" accidents can be reduced 50% through tests designed to point out the accident-prone worker, the author of this article contends. Accident-proneness, he believes, is a definite, measurable trait—probably innate—which can be detected by comparatively simple tests, and this means that the accident-prone employees can be kept out of the high-hazard jobs. In this article Mr. Drake describes the experiments which led him to this view and points out their implications for industrial management.

Supervising Women Employees, by H. W. Hepner. (*Personnel, U.S.A., March,* 1942, *Vol. 18, No. 5, p. 269*).

The influx of women workers into war industries has begun to pose new and perplexing psychological problems for many employers. In this article an industrial psychologist charts the mental and emotional differences between men and women, and lays down the principles that any supervisor in charge of a group of women must keep in mind if he wishes to develop an efficient, contented working force.

FOUNDRY, MOULDING, PATTERNS.

The Wet Process of Core Removal, Cleaning of Castings and Sand Reclamation, Hydro-blast System, by R. Webster. (*Foundry Trade Journal, February 19, 1942, Vol. 66, No. 1,331, p. 117*).

The hydro-blast gun directs a stream of sand and water against the casting at a pressure of 1,200 lb. per square inch and velocity 20,000 ft. per minute. Cores, etc., are removed and castings cleaned without production of dust, and the sand can be recovered in a washed and graded condition.

(*Supplied by the British Non-Ferrous Metals Research Association*).

The Design of Injection Moulds. (*Machinery, April 9, 1942, Vol. 60, No. 1,539, p. 285, 4 figs.*).

The basic elements of any injection mould are briefly : (1) Sprue, the part in the path of the plastic's flow which connects the nozzle of the heating cylinder with the channel leading to the mould cavity, (2) Runner, the channel between the mould end of the sprue and the mould cavity proper, (3) Gate, the orifice between the runner and the mould cavity, (4) Knockouts, the assembly, comprising a rail and pins, which ejects the formed plastic part from the mould cavity, and (5) Mould shoes, the members mounted between the mould cavities and the press platens to support the mould cavities. Good and bad examples of injection-moulding unit. Construction of gates. Design of knock-out assemblies. Formation of cavities. Thin-walled castings. Heavy sectional castings.

HEAT, HEAT ECONOMY.

Thermochrome Temperature Measuring Crayons, by F. Penzig. (*Z.V.D.I., Vol. 85, No. 2, January 11, 1941, p. 48*).

The use of temperature sensitive paints for thermal investigation is by now well known. The author describes a new development in the form of crayons by means of which selected points on the body under investigation can be conveniently marked. By this means it became readily possible to ensure that every point of a complicated die has reached the requisite temperature and that the preheating of the material before welding has been carried out properly. Other fields of application cover extrusion processes, heat insulators, ovens, etc. The temperature corresponding to the colour change is accurate, to within $\pm$ 5°C. Crayons for the following critical temperatures are available.

Temp.			
120°C.	*Initial colour* :	Light green.	*Final colour* : Blue.
150°C.		Green.	Violet.
200°C.		Blue.	Black.
300°C.		Green.	Brown.
350°C.		Brown.	Red.
450°C.		Pink.	Black.
510°C.		Light yellow.	Orange.
600°C.		Dark blue.	White.

(*Communicated by the D.S.I.R. Ministry of Aircraft Production*).

MACHINE ELEMENTS, DESIGN.

Study of Rolling-mill Bearings (**F**), by A. Beneteau. (*Rev. Met., August, 1941, Vol. 38, No. 8, p. 193*).

Advantages, disadvantages, and design of bearings of wood, compressed plastic-impregnated textiles, and compressed bakelite-impregnated wood.

(*Supplied by the British Non-Ferrous Metals Research Association*).

MACHINING, MACHINE TOOLS.

Speed and Feeds for Drilling and Reaming, by A. C. Siegel. (*The Tool Engineer, U.S.A., February, 1942, Vol. XI, No. 2, p. 65, 1 fig.*).

Balanced Wheels give Best Work, by H. J. Wills. (*The Machinist, April 4, 1942, Vol. 86, No. 54, p. 1,309, 5 figs.*).

Out-of-balance is one of the most formidable enemies of good finish in grinding. How it can be detected and corrected. Rebalance after mounting. Equipment detects out-of-balance. A portable device makes it unnecessary

to dismount the wheel from the grinding machine when balancing. It uses a vibrometer and a stroboscopic light to detect out-of-balance conditions. Do not try to correct the balance by chipping out the wheel and adding lead.

CHIPLESS MACHINING.

Precision Pipe Bending—I and II. (*The Engineer, April 3, 1942, Vol. CLXXIII, No. 4,499, p. 292, 2 figs., April 10, 1942, Vol. CLXXIII, No. 4,500, p. 312, 17 figs.*).

PART I : An entirely new technique in pipe-bending methods, introduced and developed by Blackburn Aircraft, Ltd. A greatly improved degree of precision and interchangeability of the finished parts is made possible without the use of skilled craftsmanship. Application to aircraft work. Pneumatic press for pipe bending. The principle of the jigs or dies used. Bending in one plane. PART II : Punch die and finished pipe. Double-action dies. Forming loop bend. Bending in plane normal to press stroke. Helical-faced tools for producing hook bend. Pipe bending in two planes. Preparation of the pipe. Filling the pipe. Unloading the pipe. Finishing off. Cleaning. Effect on wall thickness. Typical examples of production times.

MANUFACTURING METHODS

Saving Time in the Milling Department. (*Machine Tool Review, January, February, March, 1942, Vol. 30, No. 180, p. 4, 15 figs.*).

Original and revised method of milling dovetail slides on a vertical milling machine. Original and revised methods of milling headstocks on four machines. Original and revised methods of milling the edge and underside of the bed ways. One against two settings. Two operations on roller carriers at one setting on a horizontal milling machine.

The Spitfire in Production, by Wilfred E. Goff. (*Aircraft Production, May, 1942, Vol. IV, No. 43, p. 332, 26 figs.*).

PART II : Building the fuselage. Monocoque section, rear fuselage, and engine mounting. Control surfaces. Final assembly.

MATERIAL, MATERIAL TESTING.

Considerations of Bearing Metal Application. (*Mechanical World, April 17, 1942, Vol. CXI, No. 2,885, p. 341, 5 figs.*).

Drastic cut in tin consumption for white metal bearings. Reduction in the thickness of bearing linings, together with the discarding of "dovetailing" has produced remarkable results and is a general feature. The influence of design on the load capacity and life of bearings. Test apparatus used to determine the load required to shear white metal from a steel bush. Old and new methods compared.

Non-ferrous Metals. Summary of British and American Specifications. (*British Standards Institution, B.S. Schedule 1,007—1942, p. 120*).

The handbook, which has been prepared at the request of the Ministry of Supply, comprises a series of tables giving a summary of information from specifications for non-ferrous materials, issued by the following standardising bodies. *British* : British Standards Institution (B.S. specifications), Ministry of Aircraft Production (D.T.D. specifications). *American* : American Society for Testing Materials, U.S. Federal Specifications Board, Society of Automotive Engineers (including Aeronautical Materials Section). Due to the fact that

the basis on which specifications are drawn up in the two countries is not identical, it has not been found possible to prepare the tables on the lines of strict equivalence.

(*Communicated by the Nickel Bulletin*).

Aluminium Bronzes, by W. Ashcroft. (*Metallurgia, March, 1942, Vol. 25, No. 149, p. 148*).

A brief summary of alloys available and their properties and applications.

(*Supplied by the British Non-Ferrous Metals Research Association*).

New Magnesium Alloy. (*Metal Industry, Vol. 60, No. 8, February 20, 1942 p. 147*).

The addition of 6% silver to Dowmetal " X " (3% Al, 3% Zn, 0.2% Mn) produced the strongest magnesium alloy yet found. In extrusions it is heat treatable to a tensile strength of 55,000 lb. per square inch, a yield strength of 45,000 lb. per square inch, and an elongation of 7%, which approaches the properties of the commonly used 24 S-T aluminium alloy extrusion (60,000, 44,000 12% respectively) which, however, weighs 50% more. This alloy is not yet adaptable to sheet. The best material so far produced which is workable is considerably weaker than Alclad 24 S-T sheet, but the thicker sheet which will have to be used for aircraft skins would have the advantage of greater stiffness under compressive and shear loads. The 6% of silver in the alloy would about double the cost of magnesium alloy in ingot form. It would however, provide an outlet for some of the 200 million ounces of silver produced yearly in the Americas, of which two-thirds has no use at present. If a 6% silver alloy saves weight in aircraft, it will doubtless be worth the cost, as it has been calculated for civil aircraft on the basis of a five-year life and eight hours' daily flying that the income per lb. of dead load comes out to be about $35 per oz., so that weight saving is literally worth its weight in gold. This, also, incidentally points out the need for close tolerances on aircraft sheet.

(*Communicated by the D.S.I.R. Ministry of Aircraft Production*).

Recent Swedish Progress in Powder Metallurgy, by H. Unckel (D. W. Rudorff). [*Met. Ind. (London), March 13, 1942, Vol. 60, No. 11, p. 188*]

An account by D. W. Rudorff of a paper by Unckel published in *Teknisk Tidskrift, 1941, Vol. 7, No. 53.* Compacts of a number of binary mixtures of Cu with W, graphite, Zn, Sn, and Al were made and the structures and properties were studied. A porous 86Cu/10Sn/4Zn alloy intended for self-lubricating bearing metal was also investigated.

(*Supplied by the British Non-Ferrous Metals Research Association*).

MEASURING METHODS, APPARATUS.

Quality Control in Production Engineering, by H. Rissik. (*Machinery, April 9, 1942, Vol. 60, No. 1,539, p. 291, 4 figs.*).

Quality control in practice. Stability test. Control chart applied to a milling operation. Purposive control. Relation between control and engineering limits. Quality control as an aid to production. The statistical control of quality is a technique that merits the closest investigation by every inspection organisation anxious to obtain the best results from its efforts to maintain objective quality standards.

METALLURGY OF STEEL.

Molybdenum High-speed Steels, by L. C. Grimshaw. (*The Tool Engineer, U.S.A., February, 1942, Vol. XI, No. 2, p. 61*).

The use of molybdenum as a substitute for tungsten in high-speed steels is an old idea. But molybdenum decarburizes more readily than 18-4-1 and is more susceptible to grain growth. The metallurgists found a simple treatment, inexpensive to use, so that this one drawback is negligible. Comparison of analyses. Prevention of decarburization. Salt bath keeps tools clean. Borax coated tools. Heat treating molybdenum steels. Treatment of cobalt steels. Hardening temperatures. Forging molybdenum steels. Brazing and welding.

Steels and Alloys Developed for Use at Elevated Temperatures in Petroleum Refineries as Still Tubes and other Parts, by B. B. Morton. (*Transactions of the A.S.M.E., February, 1942, Vol. 64, No. 2, p. 113, 8 figs.*).

The steps which have been taken in the development of steels and alloys for use at elevated temperatures. Various tests such as creep, rupture, and relaxation which have been used in this development, are briefly discussed. A review is also given of the effects of the different alloying elements upon the steels and alloys.

RESEARCH.

Tests on Emery Wheels and the Grindability of Metals, by K. Gottwein. (*Z.V.D.I., Vol. 85, No. 2, January 11, 1941, p. 43*).

The author estimates the relative performance of emery wheels by measuring at regular intervals of ten seconds the temperature of a steel ring mounted on plastic bushes. The emery wheel is pressed against the ring at a constant pressure and the amount of material removed was estimated from changes in diameter. The wheel characteristic is obtained by plotting change in diameter after ten seconds against rise in temperatures during the same interval, the figure of merit depending on the steepness of the curve, i.e. lowest temperature rise for maximum abrasion. Wheels of different grain size and different hardness were used, and it appears that generally speaking a soft wheel of small grain size is the most efficient for grinding hard steel, provided the wear of the wheel keeps within tolerable limits. The relative grindability of metals can be estimated with the same apparatus. It is found that the relative order is the same for wheels of different hardness and grain size, provided the wear and "smear" of the wheel are not excessive.

(*Communicated by the D.S.I.R. Ministry of Aircraft Production*).

SHOP MANAGEMENT AND EQUIPMENT.

Union Participation in Job Evaluation—a Case History, by Harold B. Bergen. (*Personnel, U.S.A., March, 1942, Vol. 18, No. 5, p. 261*).

Job evaluation procedures, once shunned by organised labour, are evolving into an instrument of union-management co-operation, as the case history here presented demonstrates. Mr. Bergen tells how job analysis—as a joint management-labour project—paved the way for the settlement of a complicated wage dispute. He outlines the principles followed in the case and describes the exact steps which insured the successful outcome of the undertaking. Job evaluation, he predicts, if carried on with full union participation, may become a powerful force for industrial peace.

SMALL TOOLS.

Economy in Tungsten Steels. (*Machine Tool Review, January, February March, 1942, Vol. 30, No. 180, p. 9, 11 figs.*).

Suggestions are given in which ways high-speed steel can be salvaged and put to further use. Milling cutter body, tip, and cutter after welding. A finished milling cutter with welded teeth. Welding fixture for a side and face cutter. Method of cutting up a Coventry die for tipping lathe tools. Cementing tips made from dies on the Coborn electric tool tipper. Worn thread milling hobs and other milling cutters can be salvaged to provide steel for a variety of purposes.

SURFACE, SURFACE TREATMENT.

The Nitriding of High-speed Steel, by I. Stewart. (*Mechanical World, Apri 24, 1942, Vol. CXI, No. 2,886, p. 359, 1 fig.*).

The customary procedure is to immerse the tool in the fully hardened and tempered condition in a fused mixture of molten cyanides at approximately 570°C.. The time of immersion is largely decided by the mass of the tool and may vary from ten minutes to a number of hours. The result is a considerable increase in hardness at the immediate surface and a marked improvement in the cutting properties. Limitations of the process. Requirements of cyanide bath. Mode of operation. Hardness characteristics. The hard skin obtained is very thin so that normal hardness testing methods are of no use. A load of no more than ten kilogrammes is used, and the standard Vicker's machine is quite suitable.

Rust Prevention, by E. E. Halls. (*Aircraft Production, May, 1942, Vol. I V, No. 43, p. 355*).

The advantages of lanolin compounds for the protection of ferrous materials. Preparation of material. Essential properties. Characteristics of rust preventers. Test results.

The Surface Finishing of Concrete Structures, by Norman Davey. (*Journal of the Institution of Civil Engineers, April, 1942, Vol. 18, No. 6, p. 183, 32 figs.*).

Experimental investigation and survey of structures. General conclusions. (1) Control of the mix, (2) design of formwork, (3) method of placing, (4) construction joints, (5) types of finish (i) board marked textures (ii) smooth finishes (iii) exposed aggregate (iv) special aggregates (v) colour (vi) applied coverings (6) conditions of exposure.

WELDING, BRAZING, SOLDERING.

The Weldability of Steels, by W. H. Bruckner. (*Welding Jour., January, 1942, Vol. 21, p. 55, suppl.*).

The weld-quench test, as originally developed by the author, is described in *Proc. Amer. for Testing Materials, 1938, Vol. 38, Part II, pp. 71-97.* The present paper reports further study of the test as a means of assessing the weldability of steels of varying composition.

(*Communicated by the Nickel Bulletin*).

Welding the Stainless Steels, by H. S. Marquand. (*Welding, April, 1942, Vol. X, No. 3, p. 57, 3 figs.*).

Expansion of material. Preparation for welding. Jigs and fixtures. Dump trucks for the transportation of pastry dough. Dye vats of stainless steel,

5 ft. by 3 ft. 6 in. by 4 ft. 6 in. deep, complete with mild steel framework. Welding stainless steel to mild carbon steel.

Contact Resistance in Welding, by T. Tylecote. (*Weld. J. Suppl., December, 1941, p. 591*).

The fundamentals of plate-to-plate contact resistance in spot-welding are discussed and methods and apparatus for its determination examined. After mentioning the " types " of contact area to be encountered, the author analyses initial investigation of surface conditions, and explains how resistance values were obtained by D.C. resistance measurements. The effects of pressure and upset pressure are outlined. A specially devised cathode-ray oscillograph is then described in detail. It contains three gas-focussed tubes for measuring respectively the potential drops between the two sheets to be welded, one sheet and an electrode, and the drop across a shunt placed in the electrode holder. Some particulars of the welder are given and results obtained by welding materials with different surface treatments are analysed.

(*Supplied by Met.-Vick. Research Dept.*).

Portable Spot Welding. (*Mech. World, January 23, 1942, p. 83*).

Features of portable spot-welding equipment are discussed and one of the main advantages is said to be the possibility of jig-assembling the work without the necessity for limiting the total weight. A Metro-Vick portable spot-welding machine is described, and some particulars of the control equipment given. It contains water-cooled transformer and secondary leads to the welding tongs, and has a special controller equipped with three synchronous mechanical timers. The machine also incorporates " woodpecker control " which is stated to produce very consistent welds and to reduce the deformation of the copper electrode tips.

(*Supplied by Met.-Vick. Research Dept.*).

The Cost of Arc Welding, by D. J. W. Boag. (*Welding, April, 1942, Vol. X, No. 3, p. 51, 9 figs.*).

The power cost. The fixed cost. The labour cost. The electrode cost. The additional overhead cost. Total cost expression. Approximate general cost. Power cost chart.. Fixed and labour cost chart. Electrode cost chart. Costing example. Cost estimate. Individual application

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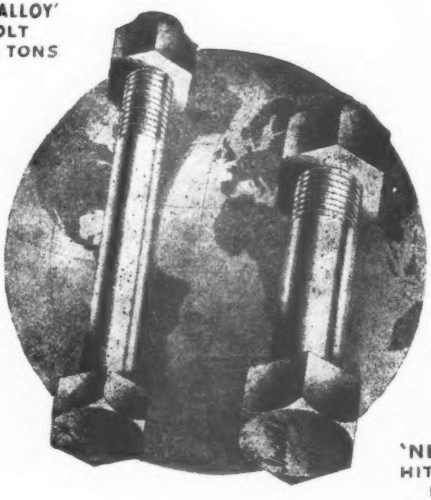

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